DIY

Worthwhile projects you can build on your own

Setting up a cross-band repeater

Some years ago my wife Lisa KR5LYS and I served on the communication committee for our LDS stake during a Mormon pioneer re-enactment trek in Wyoming. Our entire 400-person camp, except for a few crew members, took three days to walk fifteen miles from Martin's Cove to the Sage Campground at Rock Creek Hollow. Pulling handcarts. In the summer heat. In period costumes. And even before we started walking, we noticed a problem.

We were out in the middle of nowhere, so there was no cell service, except at the start, Martin's Cove. Poor kids! There were needs that had to be communicated between the start of the camp and the destination, including food questions, sheltering missteps, and minor medical issues. And the only way that communication could happen was for a crew member to drive the 25-mile one-way route on the dirt and paved roads around to the other end, and back.

As luck would have it, it just so happened that we brought along a mobile unit (Yaesu FT-8800R) capable of what's known as *cross-band repeating*, which means that it can act as a repeater, just like the ones on the mountain that you talk through all the time. (I like to abbreviate it *XBR*, because it's my way of contributing to a world that doesn't have enough acronyms and abbreviations.) Only difference is that this kind of repeater will receive your signal on one band, and re-transmit it on another, which means you and your friend must be on different bands to communicate with each other, in this case 2 meters and 70 centimeters.

Once we set that up, the front of the camp was able to communicate everything they needed with the other end of the camp in seconds rather than hours, thanks to amateur radio. That simple but effective (and inexpensive!) setup amazed many of the crew. The organizers and stake leaders took notice of how useful that was, especially when a medical issue arose, and we had several. So, how did we do it? What did it take for us to set up an XBR? A simple but effective XBR requires a few things, some physical and some operational, so let's start there.

Complete XBR setup, including antenna and battery

As you can see, as far as equipment goes, a basic but powerful XBR includes the mobile rig (dual-watch is best), microphone, antenna, and battery. Since you always plan for inclement weather, place all of this on a table or box in a secured tent. A solar option also works well. I could have set up a tall antenna connected through a coax if I wanted, but for demonstration purposes, this simple setup seems a little clearer.

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Selecting the frequencies

Since this is a cross-band operation, and the two bands are 2 meters and 70 centimeters, we need to select two frequencies, one from each of these bands, to serve our needs. Sounds easy, but there are rules that govern which frequencies to choose, and satisfying all of them can be a challenge.

First, both of these frequencies must be repeater frequencies, allocated by the Frequency Coordinator according to the Utah Bandplan for repeaters, as the input or output frequencies. The list of allocated repeater frequencies is found on the Utah VHF Society website.

§ 146.70(–)	Salt Lake	WasFrnt	Ensign Peak	KC7IIB	SLCOARES	100.0	O	
§ 146.70(–)	St George	Southwest	Winchester Hills QTH	KA7STK		100.0	OCa	
§ 146.72(–)	Glendale	Southwest	Spencer Bench	WB7REL	Skyline	100.0	OA	447.450 /3576
§ 146.72(–)	Indianola	Central	Indianola Peak	WB7REL	Skyline	100.0	OA	433.650 /3576
§ 146.72(–)	Logan	North	Mt Logan	AC7O	BARC/VHFS	103.5	OXCa	449.625
§ 146.72(–)	East Salina	Central	Salina Canyon	WB7REL	Skyline	131.8	OA	448.275 /3576
§ 146.74(–)	Altamont	Northeast	Altamont	WB7CBS		100.0	OA	
§ 146.74(–)	Enterprise	Southwest	Flattop Mtn	NR7K		100.0	OX	
§ 146.74(–)	Salt Lake City	WasFrnt	U of U Hospital	KD7NX	MARA	114.8	O	
§ 146.76(–)	Cedar City	Southwest	Iron Mtn.	K7JH		123.0	OXCa	
§ 146.76(–)	Moab	Southeast	Bald Mesa	K7QEQ		88.5	OXCaRb	147.320
§ 146.76(–)	Provo	WasFrnt	Lake Mtn State site north end	W7SP	UARC		OXCal	/3352
§ 146.78(–)	Lehi	WasFrnt	Lake Mtn north end	K7UVA	UVARC	100.0	OXA	448.200
§ 146.80(–)	Cedar City	Southwest	Blowhard Mtn.	WV7H		100.0	OX	146.940
§ 146.80(–)	Lava Hot Sp , ID	North	Sedgwick Peak	AE7TA	BARC	88.5	OXA	BARC
§ 146.80(–)	Mapleton	WasFrnt	Mapleton	N6EZO		100.0	O	
§ 146.82(–)	Ogden	WasFrnt	Little Mtn	W7SU	OARC/VHFS	123.0	O	
§ 146.82(–)	St George	Southwest	Utah Hill	NR7K	DARC	100.0	OX	146.940

It's a good idea (not mandatory, but highly recommended) that the frequencies we select be *coordinated* by the Frequency Coordinator for XBR use. In the case of this demonstration, I received written permission from our Frequency Coordinator to use 147.220 MHz and 447.650 MHz, both repeater outputs. But coordinated or not, we need to make sure that both frequencies will not be in use during the time we need them, so we need to test them repeatedly prior to activating the XBR. Listen, then listen some more, then announce *This is K-N-Ø-J-I...is this frequency in use?* on *both* frequencies.

Next, we'll set one side of our dual-band mobile radio to one frequency, and set it for *simplex* operation. We'll set the other side of our mobile radio for the other frequency, also for *simplex* operation. Because both of these frequencies are normally meant for repeater (*duplex*) operation, the mobile radio might automatically assign offsets to them, requiring us to manually override the automatic setting, then setting them to simplex.

Both frequencies entered and set to simplex

Two more things: be sure to set an appropriate power level for each side, and set a tone, as needed. In our demonstration, we've set both sides to low power (the little "L" in the lower-right of each side) because that's all we need. We also set a tone of 100.0 Hz (the "ENC" at the top of each side) to prevent possibly interfering with actual repeaters that require tones that are not 100.0 Hz.

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Setting the XBR in motion

We're performing this demonstration with a TYT TH-7800, as shown in the photos, because it's simple to set up as an XBR, it's inexpensive, and it's powerful. So, all of these XBR activation instructions will be specific to that rig, although we can apply similar instructions to other modern dual-band mobile transceivers.

Momentarily press the center button (the one with only a white square), then *turn* the upper knob (of the "Main" side) until the display reads "X-RPT" as shown. Momentarily *press* the upper knob so that the display now reads "XSTART" as shown. *Press* the upper knob once more, and the transceiver is now a repeater, and the "Main" symbol disappears altogether, as shown. Instruct all the users of your XBR to tune in to one of the two frequencies, but again setting them for simplex operation, since their HTs might automatically set them with an offset.

Enter the menu and locate X-RPT

Press the knob to select X-RPT

Press once more and it's now a repeater

Staying with our XBR

Once we start our XBR going, according to the rules, ***we must stay near our XBR at all times that it's running in XBR mode***. This is so that we can announce our ID on both frequencies manually (because our XBR is incapable of doing so properly automatically) and so that we can satisfy the rule stating that we must be in immediate control of our equipment at all times it's running.

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Wait a minute...something's wrong here. What's the *point* of running an XBR if we have to stay with it to manually ID all the time? The primary purpose of XBR is to save time and effort, in this case the effort of recording all those messages between distant stations and then relaying them. When running an aid station on a hilltop, for example, that makes sense, since we'll need to be there anyway, to provide event participants refreshments and medical attention if necessary.

To ID an XBR properly, you must take the repeater offline (take it out of XBR mode), announce your ID on one of the sides, switch to the other side, announce your ID again, then return the transceiver to XBR mode. This is why the transceiver must be accompanied by a microphone.

To exit XBR mode, momentarily press the center button (the one with the single white square). To re-enter XBR mode, repeat the original steps; that is, momentarily press the center button, momentarily press the upper knob (of the "Main" side), then press the upper knob once more.

Baofeng repeater

The mobile transceiver we've been using for this demonstration has built into it the seeming ability to receive a signal and transmit it nearly simultaneously, just like a mountaintop repeater. But it's also possible to create such a "repeater" setup by using a pair of regular handheld transceivers (HTs) that do not have the XBR function built in. At the same time, setting up something like that will help us appreciate the built-in XBR function of our mobile transceiver.

This demonstration seems to work best when using the Baofeng UV-5R series of HT, and we just happen to have a couple of UV-5XP models handy, so we'll demonstrate with those. We'll also need to get hold of a stereo patch cable, with a 2.5 mm plug on one end, and a 3.5 mm plug on the other end. This cable should be at least eight feet long, preferably twelve feet long, but not longer than about fifteen feet, because of the signal loss due to the length resistance. The one we have is nine feet long, far from ideal, but long enough to reasonably separate the two radios and yet maintain signal integrity.

Turn on one of the HTs, which we'll call the *transmitter*, and press the **V/M** button to set it to VFO mode ("Frequency Mode"), then set its upper ("A") display to 147.220. Also, press **Menu** to enter the menu, and locate the "VOX" setting (menu 4). Press **Menu** again to modify the VOX setting, then use the arrow keys to locate setting 10, then press **Menu** to save the setting. Locate the "SFT-D" setting (menu 25) and set it to OFF for simplex operation.

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Next, turn on the other HT, which we'll call the *receiver*, and set it to VFO mode, then set its upper display to 447.650, but *do not* enable its VOX feature. Be sure to set its "SFT-D" to OFF as well, for simplex operation.

Adjust the power and tone settings as appropriate, and turn off both radios. Plug the stereo cable into the radios, the 3.5 mm plug into the 3.5 mm jack of the transmitter, and the 2.5 mm plug into the 2.5 mm jack of the receiver, placing the two HTs as far apart as possible. Turn on the transmitter, with its volume turned all the way down, then the receiver, with its volume at a comfortable level. Once again, instruct your operators to tune to one of the two frequencies, and set them for simplex operation.

You're all set for XBR operation, but *only for one way*; stations calling in with the receiver frequency will get their signal re-transmitted by the transmitter. To establish two-way communication with our Baofeng XBR, we need to set up two more HTs and a second stereo cable, but in the opposite configuration: set the transmitter to 447.650 simplex, with the VOX set to 10, and the receiver to 147.220 simplex, with the VOX disabled. So, it takes four Baofeng HTs to do the XBR of a single mobile transceiver that's got the XBR function built in, but in the end it'll be a lot less expensive.

Conclusion

If you need to set up your own temporary, little repeater, a simple cross-band repeater might be your solution. Because it's a repeater, it requires the use of repeater frequencies as outlined in the Bandplan, but must in turn be used by your setup in simplex mode only, by both your cross-band transceiver and the stations that communicate with it. The setup is not difficult, especially if you're using a mobile transceiver with the cross-band feature built in, and you need to remain near it.

But if you don't have a cross-band-capable mobile unit, which can be expensive, you can also create a cross-band repeater using a pair of Baofeng handheld transceivers and a stereo cable for each direction. Too fun!